Space Weather Technical Forecast

Issued on Wednesday, 02 August 2023 at 01:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: R1-R2 Blackouts expected Day 1, with a chance of R3. R1-R2 Blackouts likely Days 2-4. Glancing blow CME arrivals anticipated Days 3-4 (04-05 Aug) with G1/Minor Storm possible.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate solar activity with occasional M-class flares, peaking at M3.6 at 01/0657 UTC from AR3380 in the southwest. There are currently eleven sunspot regions on the disc, with AR3380 in the southwest the largest and most complex, although it appears to have weakened and simplified slightly. AR3386 persists as a moderately sized region in the northwest disc and has grown slightly. AR3392 in the northeast has seen a proliferation of intermediate spots, but is not yet significantly complex. All other regions are small and simple at the present time. Despite this, AR3390 and the unnumbered region in the northeast have both been the source of a number of minor flares over the past 24 hours.

No Earth-directed CMEs were observed leaving the Sun on available imagery over the past 24 hours. However, two filament lift-offs from the northeast disc late 31 Jul (and observed on C2 imagery early 01 Aug) are considered to have Earth-directed components.

Solar Wind / Geomagnetic Activity: The solar wind at L1, as measured by ACE, was at mostly ambient levels, before a CME arrival started after 01/1100 UTC. Wind speeds varied between 350-430 km/s and are currently fluctuating close to slightly elevated levels. Density was average or below, increasing to above average after 01/1030 UTC where it has largely remained, with a peak of 25ppcc around 01/1400 UTC. The total interplanetary magnetic field strength (Bt) was initially weak, jumping to moderate around 01/1100 UTC with a peak of 13nT. The north-south component was also weak but switched from southward to northward directed around 01/0200-1200 UTC, and has weakly fluctuated since then. Phi angle remained mainly positive (away from the Sun), with brief periods of negative (towards the Sun) Phi angle. Since 01/1615 UTC Phi angle has remained negative. Geomagnetic activity was Quiet (Kp 0-2), with one Unsettled (Kp3) interval.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was initially slightly above background levels, but has trended downwards since around 01/0615 UTC and has since remained at background levels. GOES16 high energy (greater than 2MeV) electron flux varied from background to moderate levels, before increasing to high 01/1405-1735 with a diurnal maximum peak of 2010 pfu at 01/1545 UTC. The associated 24-hour integrated fluence remained below the Active level (1e8 integrated pfu), with 3.29e7 integrated pfu recorded at 02/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Activity is expected to be Moderate, with a chance of rising to High Day 1 (02 Aug) and a slight chance Days 2-4 (03-05 Aug). This is mainly due to the potential for M-flares, along with a chance of X-flares, from AR3380 on the southwest disc. Other regions contribute to the flare risk, including the anticipated return of a notable sunspot region Days 1-2.

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Solar Wind / Geomagnetic Activity: Waning influence from a recent CME arrival through Day 1 (02 Aug). Two further CMEs may give glancing blows on Day 3 (04 Aug), but possibly into Day 4 (05 Aug). Solar winds largely remaining at slow-ambient levels, perhaps increasing 400-500km/s late Day 3 or more likely Day 4 due to HSS and potential CME influence. Low confidence in details.
Geomagnetic activity is expected to be largely Quiet to Unsettled (Kp0-3), with a chance initially of Active (Kp4) intervals and a slight, but diminishing, chance of a G1/Minor Storm (Kp5). There is a further chance of Active to G1/Minor Storm intervals late Day 3 into Day 4 with forecast HSS and CME influence.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is currently at background levels. There is a slight chance of enhancement from any notable flares that occur, most likely emanating from AR3380. The high energy electron flux (greater than 10 MeV) is expected to have diurnal peaks at High (1000+ pfu) levels Days 1-2, but is likely to drop out due to HSS or CME influence Days 2-4. The associated fluence is most likely to remain below the Active threshold (1e8 total pfu), but with a brief rising trend Day 2 after any recent CME influence subsides, and before impacts from further CMEs are observed.

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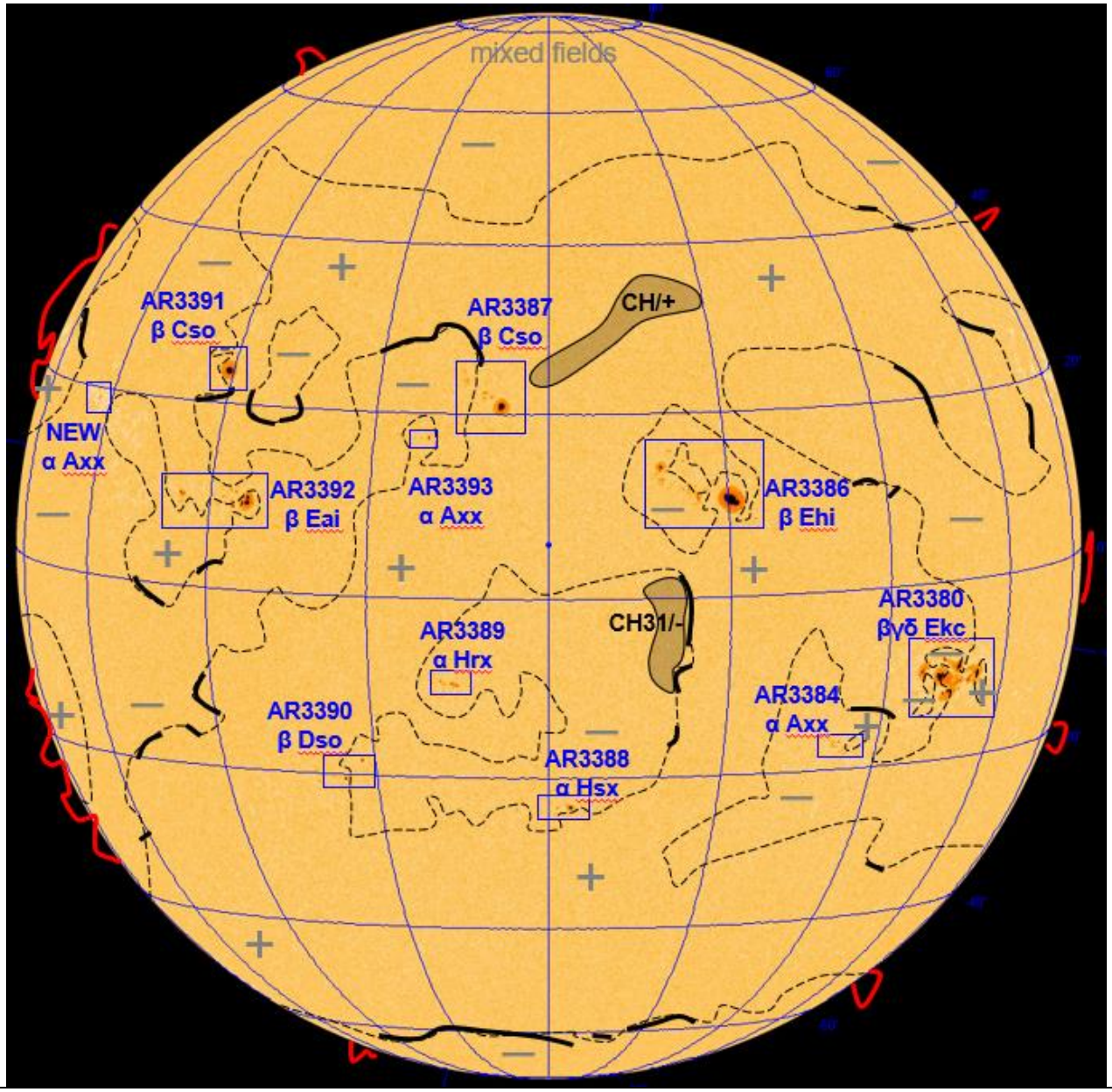
Figure 1. Solar Analysis Valid 01/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

An Earth-directed CME has recently arrived, resulting from a filament eruption observed on 28 Jul. A disappearing solar filament occurred in the centre disc from 31/1800 UTC, alongside a C5 flare from AR3380 with a CME, considered to be associated, appearing towards the southwest. In addition, two filament lift offs from the northeast disc produced a CME towards the northeast. Both of these are considered to have an Earth directed component, with arrivals anticipated on Day 3 (04 Aug), but possibly early on Day 4 (05 Aug). Low confidence due to lack of Stereo-A imagery available for analysis.

Solar winds are currently exhibiting signs of slight enhancement from the recent CME arrival, at slow-ambient levels, but close to slightly elevated levels. Influence is set to wane through Day 1 (02 Aug), with the next enhancement from connection to a high speed stream (HSS) from either CH31/- or an unnumbered CH/+ in the north-centre disc. Both these features are low confidence however, but are coincident with larger and stronger coronal holes on the previous rotation. Any enhancement from these features is expected to be either late Day 2 (03 Aug) or more likely Day 3 which may coincide with potential CME glancing influences to give speeds of 400-500km/s. Geomagnetic activity is expected to be largely Quiet to Unsettled, with a chance initially of Active intervals and a slight, but diminishing, chance of a G1/Minor Storm. There is a further chance of Active to G1/Minor Storm intervals late Day 3 into Day 4 with forecast HSS and CME influence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	15	5	30	15
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
01/0701	Partial	Filament Eruption	NE	599	04/0300 UTC	Glancing blow possible.
01/0827	Partial	Filament Eruption	SW	424	04/1400 UTC	Glancing blow possible.

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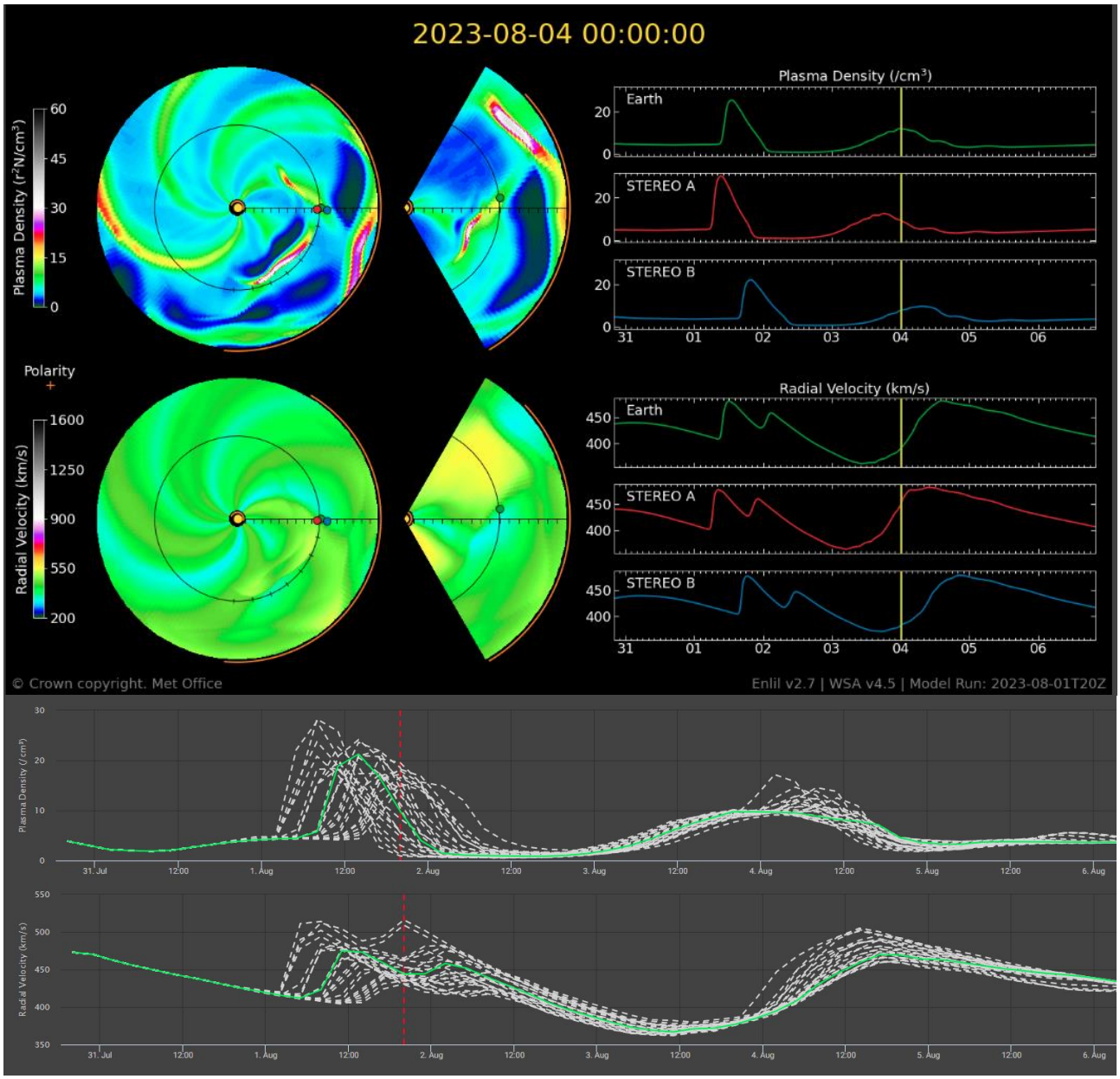
Figure 2: MOSWOC Enlil and ensemble showing further possible glancing CME blows on 04 August, with some ensemble members showing arrival on 05 August.


2023-08-04 00:00:00
Plasma Density (/cm³)
Earth
STEREO A
STEREO B
Plasma Density (r²N/cm³)
Polarity
Radial Velocity (km/s)
Earth
STEREO A
STEREO B
Radial Velocity (km/s)
31 01 02 03 04 05 06
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Enlil v2.7 | WSA v4.5 | Model Run: 2023-08-01T20Z
Plasma Density (/cm³)
Radial Velocity (km/s)
31. Jul 12:00 1. Aug 12:00 2. Aug 12:00 3. Aug 12:00 4. Aug 12:00 5. Aug 12:00 6. Aug

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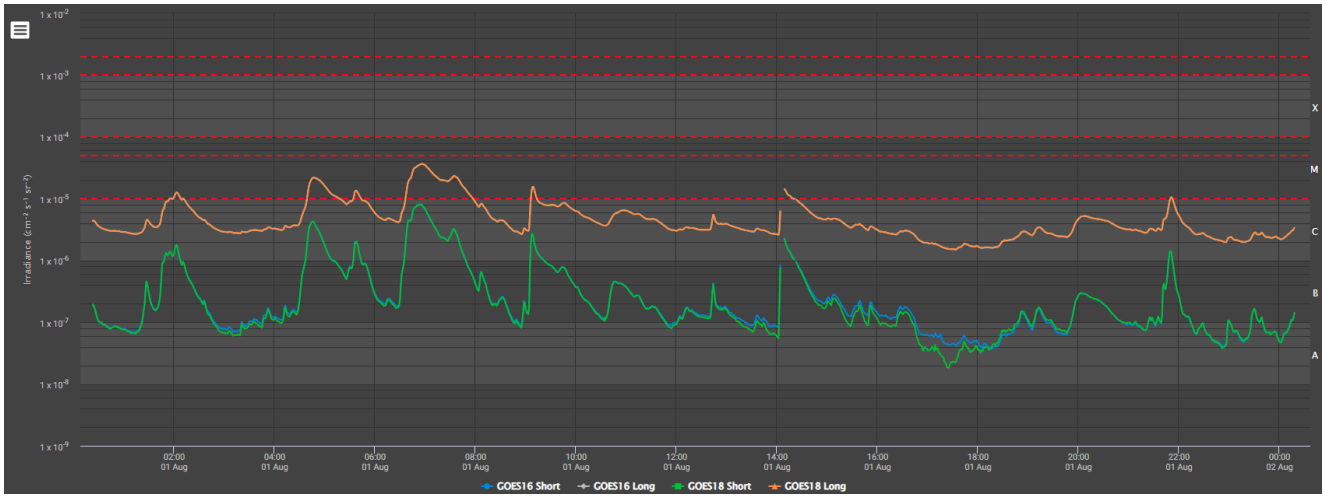
Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate. There are currently eleven sunspot regions on the visible disc, one of which remains unnumbered. The largest and most significant region on the disc remains AR3380 in the southwest. It is still exhibiting magnetic complexity, but is no longer as compact and the delta spot within the region is now marginal. This region is fairly unstable, and has been the source of a number of M-flares over the past 24 hours. Significant flares are possible, with further M-flares expected and a decreasing chance of X-flares.

Of the other regions on the disc, the only ones of note are AR3392 (Eai/Beta) in the northeast and AR3386 (Ehi/Beta) in the northwest. The former, a moderately sized region, has recently proliferated a number of intermediate spots and appears to be growing in complexity. Whereas, AR3386, another moderately sized region has seen ongoing development and fading of a number of intermediate spots and some spreading between the lead and trail portions.
The other regions on the disc are comparatively small and simple. However, AR3390 (Dso/Beta), despite its small size and relatively simple configuration has previously been the source of several M-flares over recent days. Similarly, some minor flaring has recently been observed from the unnumbered region.

Plage visible on the eastern limb along with looping just beyond the southeast limb suggest that one or more returning regions are due to rotate across the eastern limb during Days 1-2 (02-03 Aug). The latter may be the return of notable region ex-AR3363, and corresponds to a strong signal in far-side products. However there is low confidence for how much activity this region retains from its far-side transit.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	70	70	60
Very Active	R3 to R5 X Class	No	20	15	15	10

Figure 3: GOES16 X-ray trace showing Moderate activity in past 24 hours



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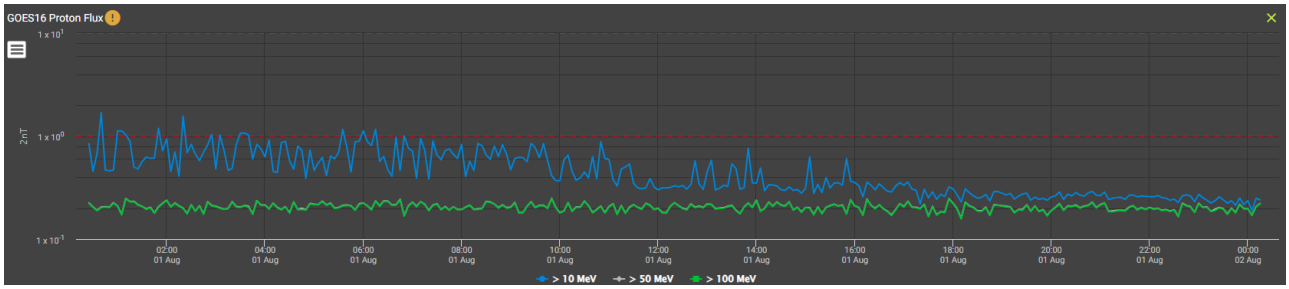
Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux has fallen to background levels having recovered from the 28 Jul far-sided eruption that brought an S2 Moderate Storm on 29 Jul.
No significant enhancement to flux levels was observed following the CME arrival on 01 Aug. The main risk of further proton storms through the period is from the complex region AR3380 in the southwest disc. Any significant flares from this region will bring a chance of further increases in proton flux, with a slight chance of exceeding S1/Minor Storm threshold.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES16 Proton Flux. Showing decline to background levels.



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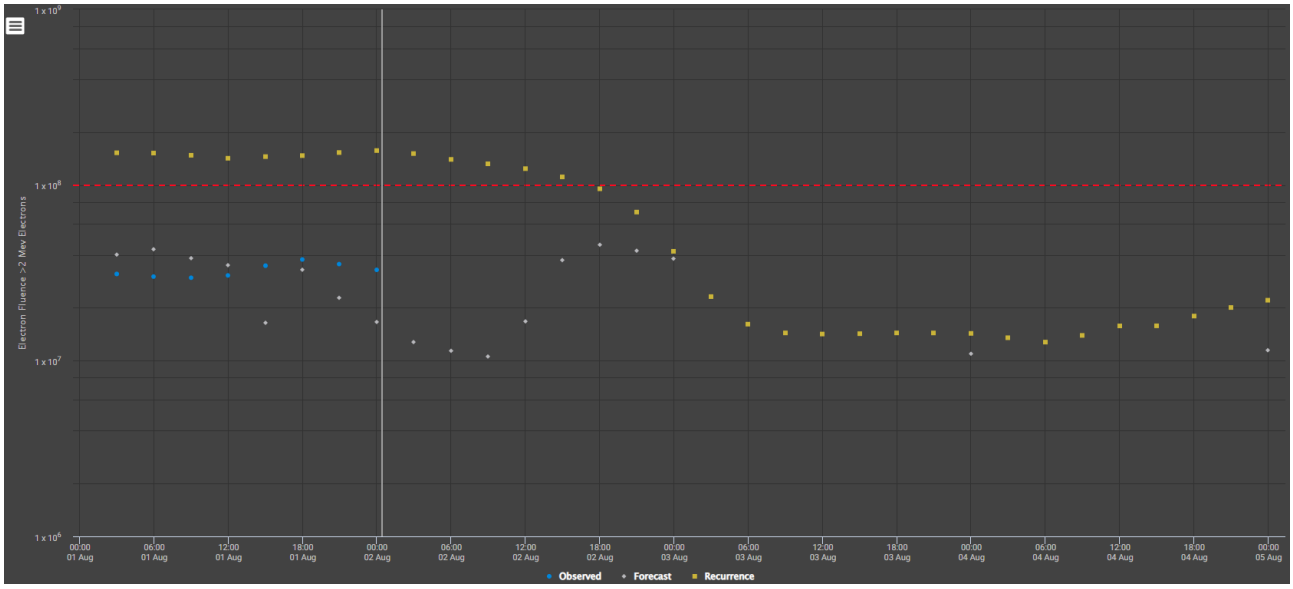
High Energy Electrons Event (≥ 2MeV):
High energy (greater than 2 MeV) electron flux observed by GOES-16 is currently at background to moderate levels but is expected to show diurnal variation to peak at High levels over the next few days. A drop out to background levels of observed flux is likely to occur during either the transition into a speed of coronal hole fast winds either late Day 2 or Day 3 (03-04 Aug) or in association with potential glancing blows from CMEs late Day 3 (04 Aug) or early Day 4 (05 Aug).

The associated 24 hour fluence is forecast to remain below Active (1e8 total pfu) but with a slight chance of rising above, mainly on Day 2 (03 Aug) after recent CME enhancement, and before subsequent coronal hole and potential further CME influence. REFM is currently giving a reasonable steer for initial conditions, but confidence in the model falls low as the period advances.

GEO Electron Environment	Level ($cm^{-2}\,sr^{-1}\,day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	10	20	15	5
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: MOSWOC REFM showing a generally below Active trend. Confidence falls low through period.



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